KATHOLIEKE
UNIVERSITEIT
LEUVEN

DEPARTEMENT TOEGEPASTE ECONOMISCHE WETENSCHAPPEN

RESEARCH REPORT 9948

IMPORTANCE OF INTERNATIONAL LINKAGES FOR LOCAL KNOW-HOW FLOWS SOME ECONOMETRIC EVIDENCE FROM BELGIUM

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D/1999/2376/48

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Some econometric evidence from Belgium

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The authors are grateful to DWTC and IWT for providing the data. Bruno Cassiman acknowledges support from a TMR grant on Foreign Direct Investment and the Multinational Corporation (FMRX-CT98-0215). Veugelers acknowledges support from FKFO grant (G. (G.0131.98) and CNRS (Enjeux economiques de l'innovation). Comments from the seminar participants in the CESSEFI Conference, Paris, May 1999 and CEPR/IMOP Workshop, Vouliagmeni, Greece, September 1999, and more particulary from J. Haaland and B. van Pottelsberghe de la Potterie, are gratefully acknowledged.

Abstract

External knowledge is an important input for the innovation process of firms. Increasingly, this knowledge is likely to originate from outside of their national borders. This explains the preoccupation of policymakers with stimulating local technology transfers coming from international firms. We find that firms that have access to the international technology market are more likely to transfer technology to the local economy. In doing so, we qualify the traditional assertion that multinational firms are more likely to transfer technology to the local economy. Once controlled for the superior access to the international technology market that multinationals enjoy, we find that these firms are not more likely to transfer technology to the local economy compared to exporting or local firms that have access to the international technology market. In summary, the main result of this paper is that it is not so much the international character of the firms, but rather their access to the international technology market that is important for generating external knowledge transfers to the local economy.

1. Introduction

Ever since innovation was identified as an important driver of economic growth, policy makers have had a keen interest in understanding how the process of developing and integrating new knowledge in the innovation process leads to successful innovation. The prosperity of a country is expected to rise with the ability to access available new knowledge which is relevant for the innovation process. Hence, it is important to stimulate the channels through which external technological information flows.

One widely recognized driver of growth of an economy is its *openness*. Building further on endogeneous growth models, the current empirical literature identifies the international transfer of technology as an important channel through which the openness of an economy encourages growth (e.g. Helpman (1997)). Eaton and Kortum (1997) for instance find domestic productivity growth to be mainly related to foreign innovations. Different channels are considered through which international technology transfers occur. The majority of empirical studies follow Coe and Helpman (1995) in analyzing the diffusion of technological know-how embodied in trade flows. But more recently, multinational enterprises (MNEs) and foreign direct investment have been introduced as international transfer channels (Lichtenberg and van Pottelsberghe (1996), Barell & Pain (1999), Baldwin et al (1999), Braconier et al (1999)). Reviewing the empirical evidence on spillovers from inward FDI, Blomström and Kokko (1998) conclude that such spillover effects exist, but that both positive and negative effects on host economies can be occuring. Despite the massive body of empirical research on the topic, and given the widespread belief among policymakers that FDI is good for growth, it is surprising that the link between technology transfers from FDI and growth is still a black box. Little is known about the conditions and mechanisms through which MNEs transfer technology. Without a clearer understanding of this, it is difficult to know what sorts of international technology transfers are consistent with growth and to distinguish positive from negative forms of FDI.

By analyzing firm-level direct evidence on the occurrence of technology flows, we identify when technology flows from international sources to the local economy are most likely to occur. Belgian company data from the Eurostat Community Innovation Survey are used, which allows us to map national and international technology transfers and technology acquisitions by companies that differ in their international exposure. The paper goes further than the existing literature by explicitly analyzing different channels through which the host economy acquires technology from these international firms. Aside from internal transfers between headquarters and affiliates, it also includes other external international transfers from which firms belonging to an international group can benefit. Access to the

international technology market is proxied by international acquisition of know-how as well as collaboration with international partners. Local transfers not only arise through the sale of technology, but also from technological cooperation with a local partner. Joint ventures or inter-firm R&D cooperation are increasingly been used as part of firm's strategy to build up and exploit technology and hence will be an important mechanism to consider as technology transfer channel.

The main result of the paper is that it is not so much the international character of the firms, but rather their access to the international technology market that is important for generating external knowledge transfers to the local economy. Companies that are sourcing technology internationally are also found to be more active in generating local know-how transfers. This implies that technology transfers to the local economy are more likely to originate from firms that have access to the international technology market through their international buying and cooperating behavior. Being part of a multinational group makes international sourcing more likely and hence, makes technology transfers to the local economy more likely. We find that this positive multinational effect on local technology transfers only arises through the improved access multinationals provide to the international technology market. Having controlled for access to the international technology market, internationally active firms fail to generate an extra effect on local technology transfers. Furthermore, we find that of the different technology transfer mechanisms, cooperation in R&D seems to be the most important one.

Unfortunately, our data do not allow us to directly measure the effect of local cooperative agreements and access to the international technology market on (growth in) productivity of firms and industries of the local economy. However, given that the wider body of existing empirical work on the effects of international technology transfers on growth, leaves inconclusive evidence, we feel that distinguishing between the issue of existence of international transfers and the issue of their effects on growth is an important first step for getting a clear view on this important relationship.

The outline of the paper is as follows. In the next section we briefly review the literature. Section 3 lays out the research question and discusses the sample. In Section 4 we present the main results of our analysis of the innovation strategy of manufacturing firms located in Belgium. Section 5 concludes.

2. The impact of know-how flows on the host economy

Most empirical studies follow Coe & Helpman (1995) in analyzing international R&D spillovers via trade flows (a.o. Engelbrecht (1997), Keller (1998), Lichtenberg & van

Pottelsberghe (1998)). Only recently, empirical and theoretical models in International Trade have started to focus on the effects of MNEs on growth (see a.o. Lichtenberg and van Pottelsberghe (1996), Barell & Pain (1999), Baldwin et al (1999), Braconier et al (1999)). The results of these studies seem to suggest that FDI-related R&D spillovers do exist, but the significance of the results depends on the level of aggregation of the data. In Industrial Organization, the topic of the impact of MNEs on host economies, has enjoyed a longer tradition. In one of the early contributions to the literature on multinationals and host country benefits, Caves (1974) distinguishes between three benefits of the presence of multinational firms in the host country (see also Blömström and Kokko (1998) for a review). First, the increase in market competition due to the entry of a foreign subsidiary increases allocative efficiency and decreases the excess profits realized by the domestic firms. Second, domestic firms in monopolistic markets will increase their level of technical efficiency or X-efficiency. This benefit flows from either the competitive effect of the multinational entry or through a demonstration effect. Finally, the entry of the subsidiary of a multinational can speed up the transfer and diffusion of technology in the local market and hence, increase the rate of innovation in the host country. Transfers of technology occur through interactions with local firms, such as technical support to local suppliers and customers or R&D contracting. However, internationally transferred know-how may also spill over to local firms through many informal channels such as movement of personnel, conferences and meetings, and patent applications among others. Caves (1974) finds that average profit rates are lower in industries with a higher percentage of foreign subsidiaries. This result partially indicates that excess profit levels vary inversely with the degree of foreign ownership and supports the hypothesis of increased allocative efficiency. At the same time, he finds that in industries that have a higher percentage of output produced by foreign owned firms, domestic owned firms have higher value added per worker. This is consistent with domestic firms increasing their technical efficiency and taking advantage of technology transfers by the multinational firms. Empirical studies at the firm level (a.o. Lall (1980), Caves (1996)) seem to suggest that spillovers are significant, but not always positive. Related, Mansfield and Romeo (1980) found that two third of UK firms indicated that their technological capabilities were raised by technology transfers from US firms to their overseas UK subsidiaries. But only 20% felt this effect was of importance. A critical factor to exploit spillovers is the technological capability of indigeneous firms. (Blomström (1986)). Also Cantwell (1989) stresses the need for a high level of local competence, a competitive environment and sound host policies to be able to absorb spillovers from multinational presence. In more recent work, Blömström and Sjöholm (1999) have found that labor productivity of Indonesian firms is higher in industries that have a higher degree of foreign owned firms. This effect is stronger for non-exporting domestic firms, which is consistent

with the idea that these productivity effects are triggered by increased competitive pressures in industries with a higher foreign ownership share.

While MNEs may or may not generate positive spillovers for the host economy, they might at the same time extract know-how from the host economy. Through their foreign affiliates MNEs may find it easier to absorb knowledge spillovers. To the extent that the MNE interacts with agents in the home market, this know-how may then spill over to the home country. Evidence for technology sourcing as motive for FDI is provided by Kogut and Chang (1991), Neven and Siotis (1996). A rapidly growing body in the international management literature emphasizes that innovation strategies increasingly require global sourcing.[1] As a consequence, subsidiaries are increasingly more likely to become an important active force in the innovative strategy of the MNE. With global innovations, international R&D units are more and more engaged in cross-border interactions both across units within the MNE as between units and external partners, resulting in more intense international know-how flows around firms that are units of international firms (Westney (1997), Bartlett and Ghoshal (1997)).

When the MNE uses its affiliates to source international know-how, also the home country of the multinational experiences benefits and costs of international technology diffusion through MNEs. This effect has been much less researched. Globerman et al (1996) for instance find positive feedback effects for outward FDI in Sweden, at least when affiliates of Swedish MNEs are located in the US, Japan or Germany. For the same Swedish MNEs, Braconnier et al. (1999) find no conclusive evidence of FDI transmitted R&D spillovers, affecting parent firm level productivity, even when distinguishing foreign affiliates by the extent to which they conduct R&D abroad. Recent direct firm level empirical evidence on intra-MNE transfers can easily show the transfers of know-how from parents to affiliates, but fails to find as yet conclusive support for the reverse direction, from subsidiaries to headquarters (Fors (1997), Frost (1998)).

Of course, MNEs are but one mechanism for international know-how diffusion. Technology is transferred internationally through other channels than subsidiaries, such as licensing, purchase of equipment, international movement of personnel, the reverse engineering of final goods and other, more informal, channels. While the existing studies have focused on involuntary spillovers, there is a growing emphasis on the importance of networking and the formation of alliances in order to access and transfer technology. Teece (1997) and Mowery (1992), for example, emphasize that alliances can be a particularly effective and often more superior mechanism for linking external technology sources. This is

[1] For some recent studies, see the Research Policy Special Issue on the Internationalization of Industrial R&D, 1999, 2-3.

because these cooperative agreements not only provide access to external know-how, but also allow for the exploitation of complementarities between partners, the sharing of risks and costs, and the internalization of spillover effects. In addition, these technological alliances allow firms to actively and voluntarily manage transfers of know-how between partners (Pisano (1990)), reducing transaction costs typically associated with market transactions (Oxley (1997)).

Furthermore, firms need not necessarily be present through affiliates in the local market to transfer know-how and to access local sources. The question of whether a local presence through affiliates is necessary for know-how diffusion, is related to the question of whether spillovers are local or not. If networks are mainly informal and tacit, then embeddedness is important and spillovers will be localized. Jaffe, Trajtenberg and Henderson (1993) using patent data show that proximity matters and that being close to an external information source increases the impact of spillovers from that source on own know-how. However, the extent to which spillovers are localized and requires local presence in order to benefit from them, is likely to be industry specific. As Irwin and Klenow (1994) show, international spillovers in the semiconductor industry are as important as spillovers between firms located in the same country. This should not surprise us given that the semiconductor industry is a typical global industry.

3. Research Question and Sample

While the existing literature has mainly focused on the role of multinational firms in technology transfers to the host country, we contend that other types of firms could also be important in transferring technology to the host economy. Local firms that export an important share of their production might also have access to the international technology market, and hence, contribute to the diffusion of internationally available know-how to the domestic economy. In addition, the data allow us to distinguish between the effect of access to international technology markets and the effect of the international exposure of the firm. Furthermore, we will consider both headquarter firms and subsidiaries of multinationals, which allows us to study transfers to the local economy both from a host and home country perspective.

Our analysis provides an answer to the question whether multinationals per se are important for realizing technology transfers to the local economy, or if this is only an indirect effect because firms belonging to a multinational group have better access to the international technology market. Therefore, our analysis contributes to identifying which type of firm is most likely to benefit an economy in terms of technology transfers, and as

such can support the policymakers in their quest for determining the most interesting targets for stimulating technology transfers to the local economy.

The analysis draws on innovation data for the Belgian manufacturing industry for 1993 that were collected as part of the Community Innovation Survey conducted by Eurostat in the different member countries. The survey intended to develop insights into the problems of technological innovation in the manufacturing industry and was the first of its kind organized in many of the participating countries. A representative sample of 1335 Belgian manufacturing firms was selected and the 13-page questionnaire was sent out to them. The response rate was higher than 50% (748). The researchers in charge of collecting the data also performed a limited non-response analysis and concluded that no systematic biases could be detected (Debackere and Fleurent (1995)).

The survey contains several questions on the technology transfer and technology acquisition behavior of innovating firms. Firms were asked about the use of different mechanisms to acquire technology nationally and internationally, the use of different mechanisms to transfer technology nationally and internationally, and the use of cooperative agreements in R&D with different types of national and international partners. We interpret cooperation in R&D as simultaneously transferring and acquiring technology. [2] This allows us to identify two types of national transfers to the local economy: the local sale of technology, and, cooperation with local partners. Similarly, two types of international technology sourcing can be distinguished: international technology acquisition, and, cooperative agreements in R&D which has an implicit acquisitive component. A possible limitation of our data is that it provides direct survey evidence on the occurrence of technology acquisition and technology transfers, but does not provide evidence on the size of these flows. However, to the best of our knowledge, the only alternative attempt to trace know-how flows *within* and *across* firm boundaries, is by tracking patent citations to previous patents (see e.g. Frost (1998) for the USPTO data). Given the vast amount of information that is transferred without writing it down in patent applications or even in formal contracts, we view our more qualitative data as an important alternative source of information on the firms' technology transfer and technology acquisition behavior.

We distinguish between four different types of companies, based on their international exposure, i.e. their ownership structure and their export behavior: headquarters of a multinational firm (*HQ*), subsidiary of a multinational firm (SUB) which can be foreign owned (*FSUB*) or domestic owned (*BSUB*), independent firms that export more than 50% of their production (*EXP*), and independent firms which sell more than 50% of their output in

[2] The survey data do not allow to identify the motives for cooperation.

the domestic economy (*LOC*).[3,4] Of the total sample, which includes innovating and non-innovating firms, 44% of the companies are local (*LOC*). Of the remaining firms, 32% are subsidiaries of an international group (*SUB*), most of which are foreign based (28% *FSUB*) and 4% of the companies are classified as *HQ*. One fifth of the companies have an exporting profile without being part of a multinational group (*EXP*).[5] This distribution is very typical for a small and open economy such as the Belgian economy, with little own multinationals but a pervasive representation of foreign affiliates and exporting firms. With respect to the distribution of firm types across industries, we find that local firms are overrepresented in food, textiles, wood and paper and other industries, but are underrepresented in chemicals and electronics. Foreign subsidiaries are concentrated in chemicals and electronics, while headquarters and Belgian subsidiaries are mainly found in chemicals, (non-ferrous) metals and textiles.

Size is strongly and significantly correlated with the international orientation. While 75% of local companies have less then 50 employees, almost two thirds of the headquarters and subsidiaries show up in the largest size categories of >250 employees. The majority of exporting companies (53%) are found in the mid-sized category, between 50 and 500 employees.[6]

In line with the industry distribution and size correlation, an international strategy is also strongly associated with innovation. While 48% of local companies are innovative, the percentage for exporting firms is 72%.[7] Members of an international group are even more active in innovation: all headquarter-type firms innovate, while 85% of subsidiaries do so. This last observation confirms that affiliates are indeed innovation-active and indicates that innovation is an important subsidiary level function. In the remainder of the paper, we will restrict the sample to the innovating companies, since the survey only provides information on knowledge flows for this subsample.[8,9]

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[3] See Appendix for a detailed description of all the variables used.
[4] Incorporating *BSUB* with their *HQ* group did not significantly alter the results of the analysis.
[5] Note that typically the *HQ* and the *SUB* category also have a high export-intensity.
[6] To compare, for the total sample, 43% is in the <50 category, 24% in the 50-250, 16% in the 250-500 and 17% in the >500 category.
[7] Innovating firms are firms that claimed to have introduced new or improved products or processes between 1990-1992 and reported a positive budget for innovation.
[8] Of the total 494 innovative companies, 32% are *LOC*, 21% is *EXP*, while 6% is *HQ* and 41% is *SUB* (35% *FSUB* and 6% *BSUB*).
[9] We have to take into account a possible sample selection bias. We only record transfers for firms that have successfully introduced new products or processes.

4. Results

In the following section we examine which firms are more likely to transfer technology to the local market. Previous research suggests that firms that operate on an international scale, especially multinational firms, are more likely to transfer technology to the local economy, and hence, should be more likely targets for policies that stimulate technology transfers to the local economy. However, our result show that the relation between international dimension of the firm and technology transfer is not so clear cut. First, section 4.1. shows some descriptive statistics on the national dimensions of technology flows through buy, sell and cooperation activities of firms with a different international exposure. Next, section 4.2 provides some evidence on the connection between access to the international technology market and technology transfers to the local economy. The core of the analysis is presented in section 4.3, with a econometric analysis on which types of firms are most likely to generate transfers to the local economy.

4.1. Local transfers of technology

In this section we analyze whether there exists a relation between the degree of international exposure of firms and their local technology transfer behavior. Table 1 shows that pure transfers of technology (*SELL*) by the firms in our data set that remain in the local market are relatively infrequent: only 17% of innovative companies transfer technology locally. Nevertheless, it is interesting to note significantly higher local technology transfers by Belgian subsidiaries. However, this should not surprise us since 74% of these subsidiaries transfer technology within the group, most likely to their headquarters. Buying of technology locally is more pervasive than local selling. But there is little difference between the different types of firms, with the exception of the Belgian headquarters, who are most active in local buying, a large part of it from their local subsidiairies.

Insert Table 1 here

As argued before, cooperation in R&D can be used to acquire as well as to transfer technology. The survey allows us to check whether partners in a cooperative agreement are national or international[10]. In comparison to local sale of technology through market transactions, cooperation with local partners occurs more often. If Belgium is likely to gain from its international firms, the hope is that these cooperative agreements in R&D are an effective mode to transfer know-how to the local economy. Especially headquarters are prone to cooperate with local partners, but also subsidiaries, including the affiliates of

[10] As partners in the cooperation can be included companies belonging to the same group or independent third parties such as research institutes, competitors, or, vertically linked suppliers or customers .

foreign firms, have a high incidence of local cooperative agreements. Of the firms with an important international exposure, the export oriented companies are the least cooperative, but their cooperative agreements have the strongest national orientation.

4.2. International innovation inputs and host economy benefits

The previous section has demonstrated that there seems to exist a positive relation between the degree of international exposure of the firm and its local technology transfer behavior. It was shown that especially cooperative agreements with local partners are more prevalent for internationally oriented firms. A next step in the analysis is to examine if there exists a link between the access firms have to the international technology market and their local technology transfer behavior. One would expect that Belgium being both host and home to multinational companies might benefit from the superior access that these firms have to the international technology market. Table 2 maps international technology acquisition with national technology transfers. We consider two mechanisms for acquiring technology internationally: firms can buy technology on the international technology market or they can acquire technology indirectly through cooperative agreements with international partners. As before, we consider two related technology transfer mechanisms. Firms can either sell technology nationally or they can transfer technology within the framework of a cooperative agreement with a local partner.

Insert Table 2 here

A first observation from Table 2 is that firms that are part of a multinational structure, have a higher frequency of buying technology internationally as well as cooperating internationally. This finding suggests that exports is not the most straightforward internationalization mode providing access to the international technology market. Belgian headquarters are the most active in international technology acquisition.[11] But also many foreign subsidiaries are acquiring technology internationally. However, we would expect that a large part of these international technology acquisitions originate with their parent companies.[12]

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[11] Not only own affiliates are used as an international technology source: 42% of headquarters that were active in international technology acquisition reported internal acquisitions within the group, i.e. transfers from their foreign affiliates.

[12] 66% of foreign affiliates located in Belgium and acquiring technology from abroad, indicated international transfers within the group, from sister or typically parent companies. Comparing the internal international transfer activities between headquarters and affiliates gives results in line with Frost (1998), namely that headquarters are more important as a source for innovation for subsidiaries than the reverse.

Companies that acquire technology internationally, either directly through a market transaction or through international cooperative agreements, are more likely to transfer technology nationally through the direct sale of technology, but especially through national cooperative agreements. In particular the case for cooperation is striking: 85% of the companies that cooperate with international partners, will also cooperate with national partners. This cooperation might occur within the same cooperative agreement or through different cooperative agreements of the firms. All this suggests that there exists an important complementarity between international and national cooperative agreements in R&D.

Two interesting observations follow from this descriptive data. First, host countries should realize that national technology transfers are more likely to occur through cooperative agreements with firms that have access to the international technology market, rather than through pure technology sale transactions. If these alliances are effective mechanisms through which technology is diffused, the Belgian economy might stand to gain substantially from its openness through exploiting cooperative agreements with firms that have access to the international technology market. Second, we should note that especially local and exporting firms become more active in local technology transfer once they gain access to the international technology markets through the acquisition of technology or through international cooperative agreements in R&D. While only 18% of local firms transfer technology locally through the sale of technology, 34% (50%) of the local firms that buy technology internationally (cooperate internationally) do so. Similarly, local firms that acquire technology internationally, either through buying or cooperating, are between one and a half to four times more likely to engage in local cooperative agreements compared to the average local firm. For the exporting firms, we find similar effects of access to the international technology market on local technology transfers. These results are already indicative of the importance of access to the international technology market, rather than belonging to a multinational firm, for explaining technology transfers to the host country.

4.3. Econometric evidence on firm characteristics conductive to local technology transfers

In this section we attempt to confirm the importance of the firms' international profile for local technology transfers in a multivariate regression analysis. Such analysis allows us to consider the various characteristics of the firm simultaneously, while controlling for other important variables, such as size, technological origin and innovative profile. A binomial probit analysis on the likelihood of local technology transfers is performed using the sample of 494 innovating Belgian firms. As proxies for local technology transfers, we use the likelihood of local technology sell (*SELLnat*) as well as the likelihood of cooperation in R&D with a local partner (*COOPEXnat*). Cooperation with local partners includes

competitors, vertically linked firms and research institutes, but excludes affiliated partners, since we want to focus on external transfers to the local economy. For selling and buying technology it was not possible to distinguish between technology transfers and acquisitions within the boundaries of the multinational and external transfers and acquisitions. For SELLnat, transfers within the boundaries of the multinational are especially important for Belgian subsidiaries transferring technology to their parents. The dummy variable *BSUB* is likely to pick up this effect.

The following explanatory variables are included (for a full detailed description of the variables, see appendix). The local firms being the reference group, the different types of firms according to their degree of international exposure are included as dummies: *EXP*, *HQ*, *BSUB*, *FSUB*. Whether the firm has access to the international technology market is measured by a dummy for buying technology (*BUYinat*) and cooperation with international partners (*COOPinat*). This international cooperation can include both external partners and affiliated partners. Firms operating within an international network of affiliates have a larger scope for international within-firm sourcing. Since we are interested in any international technology access from which the local market can benefit, we included both within-group and external partners.

The size of the firm (*SIZE*) is included as a control variable. Firms that are larger in size, which is typically the case for the international firms in the sample, may be more likely to generate local technology transfers. A quadratic size term is included as well, to check for non-linearities (*SIZESQ*). The internal innovative capacity of the firm is an important prerequisite for being able to successfully transfer technology. The dummy *PERMRD* measures whether the firm is permanently active in own research and development activities. The survey data allow us to include two other aspects of the innovative attitude of the firm which could determine technology transfer and technology acquisition decisions, namely the firm's openness to generally available external know-how (*EXTINF*) and the effectiveness of patents and trademarks for protecting know-how (*LEGPROT*). Finally a number of industry dummies are included to correct for any technological opportunities or competitive considerations that might give rise to more or less technology transfer opportunities.

Columns 1 and 2 in Table 3 report the results from estimating the probability of cooperation with local partners (*COOPEXnat*). Columns 3 and 4 estimate the equivalent equations for local technology transfers through the sale of technology (*SELLnat*). In order to disentangle the effect of access to the international technology market from the effect of the degree of international exposure of the firms on the likelihood of being engaged in local technology transfers, we first regress the local technology transfers on the control variables and variables indicating the degree of international exposure of the firm (columns 1 and 3).

Next, we add the variables on access to the international technology market (*BUYinat* and *COOPinat*) in the regression (columns 2 and 4).

We start by discussing first the results for the international character of the firm without controlling for access to international know-how (column 1 and 3). As expected, size positively affects the likelihood of local transfers, but the importance of size increases at a diminishing rate, as the negative quadratic term indicates. Permanent own R&D activities and openness to generally available external know-how, are more important to capitalize on the gains from cooperation than from local technology sell. Similarly, a capacity to appropriate the rents from innovation are conductive to local cooperation, but do not significantly affect local technology transfers through technology sale activities.

After correcting for size and innovative profile, the results reported in column 1 seem to confirm the traditional results of the literature on multinationals and technology transfers. For local cooperation, the coefficients for headquarters and subsidiaries are significantly positive, suggesting that companies operating within an international network of affiliated companies are interesting sources for local transfers. Note that exporting firms have no significantly higher likelihood to cooperate with local partners than local firms, suggesting that the mode of internationalisation matters for technology transfers.

However, after correcting for access to the international technology market, there is also no significant effect anymore for international presence on the likelihood of national cooperation in R&D, since the dummies for (*EXP*, *BHQ*, *BSUB*, *FSUB*) are positive but not significant in column 2. But firms that are internationally buying or cooperating are more likely to cooperate locally (column 2). These results confirm that for local technology transfers to occur, it is important to have firms that have access to the international technology market, both through international buy and cooperation with international partners, not necessarily firms which international operations. As a check, Table 4 reports the results on the determinants of *COOPinat* and *BUYinat*. These results confirm that firms belonging to an international network of affiliated companies (*HQ* and *SUB*), have a significantly higher probability to be actively acquiring know-how internationally.[13] This is not the case for exporting firms, confirming that the mode of internationalization matters for being able to access international know-how. In summary, the results suggest that companies operating within an international network of affiliated companies could be interesting sources for local transfers, but this only because of their larger international sourcing activities. It is the latter characteristic within an international profile which seems to be the driving force to stimulate local cooperation.

[13] This result holds not only because of international within-group cooperation, since the coefficients remain significantly positive even if *COOPEXinat* would be the dependent variable.

For local sell of technologies the picture is somewhat different. The positive effect from access to the international technology market, either through international buy or international cooperation, is also strongly present here (column 4). But besides a positive international access effect, there is actually a significantly negative effect of international presence on the likelihood of local technology sales. Internationally active firms are less likely to transfer technology to the local economy through technology sell activities, as compared to local firms, once corrected for international technology access. The exception is the non-significant effect for the local subsidiaries from Belgian MNEs, which is probably due to internal transfers to their local parent. The most interesting target for local sale of technology therefore seem to be large local firms that are sourcing technology internationally.

It is also interesting to note that when correcting for access to the international technology market, the importance of the innovation profile of the firm for explaining local technology transfers is reduced. Both the coefficients and the significance of *PERMRD* and *EXTINF* are reduced after introducing *BUYinat* and *COOPinat* into the regressions. This follows from the innovation profile of the firm being an important determinant for whether the firm has access to the international technology market, as is confirmed in Table 4.

5. Conclusions

External knowledge is an important input for the innovation process of firms. Increasingly, this knowledge is likely to originate from outside of their national borders. This explains the preoccupation of policymakers in stimulating local technology transfers coming from international firms. In the existing literature this has typically been framed as a search for multinational firms, which are presumed to transfer technology to the host country. This paper goes further by explicitly analyzing different channels through which the host economy might benefit from these transfers. Using Belgian company data from the Eurostat Community Innovation Survey it empirically examines the technology flows occurring through firms that are internationally active and/or accessing internationally available know-how and assesses their impact on transfers to the host economies.

At least three important results emerge. First, cooperation with local partners is an important explicit channel for the host country to benefit from technology transfers. At least, it is used more frequently than local sell of technology. The common policy stance favoring their formation through special legal provisions or subsidizing them through special programs seems attractive for stimulating access to external know-how. But since cooperation describes typically a reciprocal relationship, this implies that the issue of simultaneous receiving and transferring know-how cannot be ignored. Second, firms

belonging to an international network of affiliates have a higher probability that they are internationally sourcing technology. The exporting mode is much less tuned to result in international technology market access. Third, access to the international technology market is an important driver for local technology transfers. Having controlled for access to the international technology market, the international orientation of the firm has no significant effect or even a negative effect on local technology transfers. Especially Belgian headquarter firms loose attractiveness as target once controlled for size and international know-how access. Companies operating within an international network of affiliated companies are interesting sources for local transfers but mainly through their larger international sourcing activities. Our results imply that in order to stimulate local technology transfers the firm's size and its innovation profile are important variables as well to take into consideration.

In summary, these results seem to suggest that Belgium as an open economy is benefiting from its openness because of technology transfers to the local economy from firms that are sourcing internationally, even if these firms have no international activities through exports or foreign affiliates. The local economy is likely to gain from internationally operating firms, foreign and Belgian multinational firms, or exporting firms, but only to the extent that these firms have a higher probability that they are internationally sourcing technology. It is this higher probability of international technology sourcing which has a significantly positive effect on the probability of local transfers through local cooperation. An important implication of these results is that the trend towards subsidiaries with a more pivotal role in the multinational's innovation strategy, and with more discretion to use the MNE structure to source know-how globally, can therefore be expected to generate more technology diffusion to the local economy.

Before the results of this study are molded into firm conclusions about MNE's innovation strategies and host government's innovation policy, more work is needed to test the robustness of these results. First, technology transfers to the local economy might occur through many other formal and informal channels in addition to the ones analyzed in this paper. Second, our data only reveals whether or not a firm is active in transferring technology locally. Information about the intensity of these technology transfers would be necessary for any definitive conclusions about the importance of the degree of international exposure for local technology transfers. Furthermore, the Eurostat data allow us to compare results across EC countries. This would give us the opportunity to identify possible host markets characteristics which might influence the results. More importantly, the analysis should be extended beyond whether technology flows occur or not, towards assessing the efficiency of

such flows, and their impact on innovative performance and growth. In order to check for feedback effects in this relationship, a panel data structure is required.

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Tables

Table 1: Local transfers of know-how

	TOTAL	*LOC*	*EXP*	*HQ*	*SUB*	
					FSUB	*BSUB*
%SELLnat	**17%**	18%	11%	13%	17%	31%
%BUYnat	**53%**	56%	48%	67%	50%	55%
%COOPnat	**36%**	13%	30%	57%	53%	55%

TABLE 2: International Technology Acquisition And National Technology Transfer

	TOTAL	*LOC*	*EXP*	*HQ*	*SUB*	
					FSUB	*BSUB*
Cies *BUYinat* (N)	**280**	**61**	**45**	**24**	**131**	**19**
As % of total number of firms	*57%*	*39%*	*43%*	*80%*	*76%*	*63%*
%SELLnat	**23%**	34%	18%	17%	20%	32%
%COOP nat	**49%**	20%	49%	58%	59%	68%
Cies *COOPinat* (N)	**156**	**18**	**21**	**18**	**84**	**15**
As % of total number of firms	*32%*	*11%*	*20%*	*60%*	*49%*	*50%*
% SELLnat	**19%**	50%	19%	22%	24%	40%
%COOP nat	**85%**	50%	86%	89%	86%	87%

TABLE 3: ECONOMETRIC RESULTS

Binomial Probit Model; Maximum Likelihood Estimates; Number of observations = 494;

Reported are per variable the partial derivatives of E[y] with respect to the vector of characteristics (computed at the means of the Xs); standard error and significance level (***significant at 1%, **significant at 5%, *significant at 10%).

All regressions include as independent variables industry dummies (*FOOD, TWP, CHEM, ELEC, M&M*). These coefficients are not reported, since they are never significant.

	COOPEXnat	*COOPEXnat*	*SELLnat*	*SELLnat*
VARIABLE	(1)	(2)	(3)	(4)
Constant	-0.752***	-0.785***	-0.418***	-0.411***
	(0.127)	(0.139)	(0.091)	(0.088)
SIZE	0.985E-04***	0.647E-04**	0.495E-04***	0.376E-04***
	(0.29E-04)	(0.33E-04)	(0.15E-04)	(0.15E-04)
SIZESQ	-0.261E-08**	-0.157E-08	-0.143E-08***	-0.104E-08**
	(0.12E-08)	(0.14E-08)	(0.53E-09)	(0.5E-09)
PERMRD	0.189***	0.116*	0.0825**	0.0559
	(0.059)	(0.064)	(0.043)	(0.041)
EXTINF	0.377***	0.189	0.159*	0.061
	(0.118)	(0.129)	(0.085)	(0.0834)
LEGPROT	0.411***	0.36**	0.00151	-0.0358
	(0.14)	(0.154)	(0.104)	(0.102)
EXP	0.091	0.0936	-0.125***	-0.11916***
	(0.0687)	(0.0731)	(0.499)	(0.481)
HQ	0.19*	0.0461	-0.184**	-0.249***
	(0.102)	(0.115)	(0.0827)	(0.0835)
BSUB	0.175*	0.039	-0.00979	-0.0449
	(0.101)	(0.345)	(0.0694)	(0.0668)
FSUB	0.158***	0.0101	-0.111***	-0.159***
	(0.0618)	(0.0682)	(0.0449)	(0.0449)
BUYINAT		0.145***		0.132***
		(0.053)		(0.0368)
COOPINAT		0.515***		0.109***
		(0.0572)		(0.0369)
χ^2	140.8***	251.2***	33.3***	56.5***

TABLE 4: ECONOMETRIC RESULTS CONTINUED

VARIABLE	*COOPinat*	*BUYinat*
	(1)	(2)
Constant	-0.714***	-0.358***
	(0.121)	(0.118)
SIZE	0.8E-04***	0.596E-04**
	(0.261E-04)	(0.304E-04)
SIZESQ	-0.199E-08*	-0.22E-08**
	(0.112E-08)	(0.104E-08)
PERMRD	0.205***	0.0613
	(0.0577)	(0.0583)
EXTINF	0.344***	0.514***
	(0.116)	(0.123)
LEGPROT	0.215	0.224
	(0.136)	(0.151)
EXP	0.0139	-0.0141
	(0.0692)	(0.0672)
HQ	0.22**	0.278**
	(0.0979)	(0.121)
BSUB	0.20	0.0943
	(0.0961)	(0.111)
FSUB	0.217***	0.243***
	(0.06)	(0.0647)
χ^2	145.2***	104.5***

Appendix

Variables Description	
FIRM SPECIFIC VARIABLES	
SUB	Dummy variable with value 1 when the company is a subsidiary of an international group.
FSUB	Dummy variable with value 1 when the company is a subsidiary with foreign headquarters
BSUB	Dummy variable with value 1 when the company is a subsidiary of an international group with Belgian headquarters.
HQ	Dummy variable with value 1 when the company is the headquarters of an international group.
EXP	Dummy variable with value 1 when the company is independent or part of a Belgian group without foreign affiliates, but exporting more than 50% of their production abroad.
LOC	Dummy variable with value 1 when the company is independent or part of a Belgian group without foreign affiliates, and exporting less than 50% of their production abroad.
COOP	Dummy variable with value 1 for innovative firms that have cooperation in R&D, where both parties have an active involvement.
COOPnat	Dummy variable with value 1 when the cooperation is with a Belgian partner.
COOPEXnat	Dummy variable with value 1 when the cooperation is with a Belgian non-affiliated partner.
COOPinat	Dummy variable with value 1 when the partner is located outside Belgium.
SELL	Dummy variable with value 1 for innovative firms selling technology through licensing and/or through R&D contracting and/or through consultancy services and/or sale of another enterprise and/or mobility of skilled employees.
SELLnat	Dummy variable with value 1 when the transfer is to a firm located in Belgium.
BUY	Dummy variable with value 1 for innovative firms acquiring technology through licensing and/or through R&D contracting and/or through consultancy services and/or purchase of another enterprise and/or hiring skilled employees.[14]
BUYinat	Dummy variable with value 1 when the acquisition is from a firm located outside Belgium.
SIZE	Firm Sales in 10^{10} BEF.
SIZESQ	Firm Sales in 10^{10} BEF squared.
PERMRD	Dummy variable with value 1 when the firm has permanent R&D activities.

[14] We disregarded the "embodied" purchase of equipment, mainly because too many firms responded positively on this item. The reported results are not affected by the inclusion or not of purchase of equipment in the buy option. Probably not all of them interpreted the question as buying equipment with the explicit purpose of obtaining new technologies and as an alternative to developing the technology internally.

EXTINF	Sum of scores of importance of following information sources for innovation process (number between 1 (unimportant) and 5 (crucial)): 1. Patent information 2. Specialized conferences, meetings and publications 3. Trade shows and seminars. (rescaled between 0 and 1)
LEGPROT	*LEGPROT* is Sum of scores of effectiveness of following methods for protecting new products/processes (number between 1 (unimportant) and 5 (crucial)): 1. Patents for protecting products, 2. Registration of brands, copyright for protecting products, 3. Patents for protecting processes, 4. Registration of brands, copyright for protecting processes. (rescaled between 0 and 1)
INDUSTRY DUMMIES	
TWP	TWP = 1 if firm is in Textile, Wood or Paper Industry (NACE Codes: 17, 18, 19, 20, 21, 22).
ELEC	ELEC = 1 if firm is in Electrical Equipment Industry (NACE Codes: 30, 31, 32, 33).
FOOD	FOOD = 1 if firm is in Food Business (NACE Codes: 15, 16).
CHEM	CHEM = 1 if firm is in Chemical Sector (NACE Codes: 24, 25).
M&M	M&M = 1 if firm is in Metals and Manufacturing (NACE Codes: 26, 27, 28, 29, 34, 35).